GOATS'2000
Adaptive Detection, Tracking and Interrogation Of VSW Seabed Targets

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LONG-TERM GOAL

Develop environmentally adaptive sonar concepts for autonomous underwater vehicle networks for detection and classification of proud and buried targets in very shallow water.

OBJECTIVES

The objective of this sub-project is to develop adaptive responses of underwater vehicles acting as bistatic sonar platforms, including real-time, autonomous beamforming, detection and tracking algorithms, and adaptively modify the platform motion to optimally characterize the 3-D acoustic scattering by detected seabed targets.

APPROACH

The center piece of the research effort is the GOATS'2000 Joint Research Program (JRP) conducted by SACLANTCEN and MIT with ONR support. Building on the experience of the highly succesful GOATS'98 pilot experiment (Schmidt *etal.*, 1998), the JRP combines a series of experiments, with the two major ones being planned for 2000 and 2002, and modeling and simulation work to explore the potential of autonomous underwater vehicle networks as platforms for new sonar concepts exploring the full 3-D acoustic environment of VSW. The GOATS'2000 experiment will incorporate 3-4 AUV's, two of which will be operated by MIT, one equipped with a combined side-scan/subbottom profiler, and one equipped with an 8-element acoustic array, an autonomous acquisition system and 2.4 Gflop of on-board computing power for autonomous processing and adaptive control. The first vehicle will be used as a rapid environmental assesment platform and as a bi-static source platform, which together with fixed parametric source capabilities will be used to insonify the seabed. The second AUV will be used for sampling the 3-D acoustic field either using fixed or adaptive survey patterns, and as a testbed for adaptive response to target detection. The modeling effort is centered around the new OASES-3D capability developed at MIT under a sub-project funded by code 321OA (Lee 1999, Schmidt and Lee 1999). OASES-3D provides wave-theory modeling of the full 3-D acoustic environment associated with mono- and bi-static configurations in VSW with aspect-dependent targets and reverberation features.

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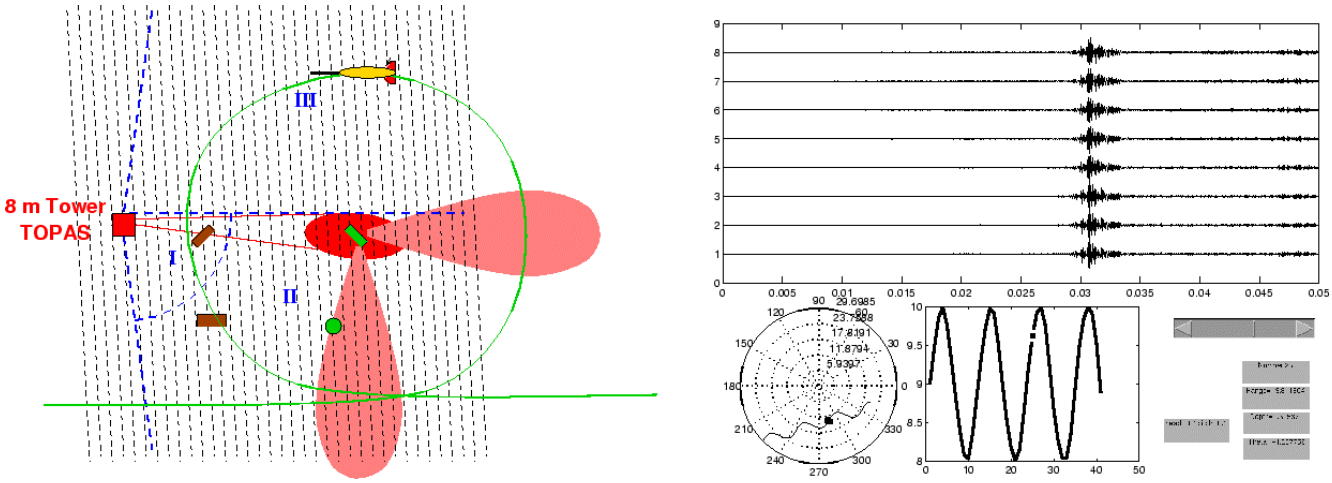
WORK COMPLETED

A significant portion of the FY99 effort has been devoted to the development of a high-fidelity simulation capability for developing acoustic sensor-adaptive AUV maneuvering. Using Matlab as software platform, a user-friendly GUI has been designed and implemented, interfacing with the high-fidelity acoustic modeling capability of OASES-3D. The simulator allows for interactive or autonomous execution of AUV mission tracks in a precomputed acoustic field, simulating the full sampling capability of the Odyssey AUV equipped with an acoustic array. The figure shows a screen-dump of a simulation session where an AUV with finite yaw and pitch variation transects the bistatic field produced by a flush-buried cylinder insonified by a parametric beam.



On the vehicle front, the acoustic acquisition system of the 'Xanthos' Odyssey AUV used in GOATS'98 has been upgraded with a new DSP board providing 2.4 Gflop of computational power for real-time beamforming of the data received on the 8-element array. The interfacing between the AUV control computer and the acoustic acquisition system has been upgraded to allow control of the data recording either autonomously by the vehicle control or remotely through the RF or acoustic modems.

RESULTS

The new capabilities of the acoustic acquisition AUV Xanthos were tested during the SITE-99 AOSN experiment in Monterey, Aug-Sep. 1999. The AUV was used as a mobile receiver platform, operating in an LBL network, with the navigation signals recorded on the ‘swordfish’ array for tomographic inversion (Willcox, 1999). The integrated control of the acoustic array and acquisition system was succesfully implemented and tested.

IMPACT/APPLICATION

The long-term impact of this effort is the development of new sonar concepts for VSW MCM, which take optimum advantage of the mobility, autonomy and adaptiveness of the AOSN. For example, bi- and multi-static, low-frequency sonar configurations are being explored for buried mines in VSW, with the traditional high-resolution acoustic imaging being replaced by a 3-D acoustic field characterization as a combined detection and classification paradigm, exploring spatial and temporal characteristics which uniquely define the target and the reverberation environment.

TRANSITIONS

The GOATS AUV effort has been and is conducted by the MIT Sea Grant AUV Laboratory, in part funded by this project and the AOSN MURI. A new AUV enterprice, Bluefin Robotics, is a spin-off from the MIT Laboratory, and is currently developing a new Odyyssey III Battlefield Preparation AUV for ONR, building in part of experience from the GOATS`98 experiment (Schmidt *etal.*, 1998)

The 3-D acoustic models for VSW MCM environments developed under GOATS are being integrated in a multi-AUV simulation capability developed by the MIT Sea Grant AUV Laboratory and Bluefin Robotics under the ONR project (Code 321TS) "Sensor and Operational Tradeoffs for Multiple AUV MCM" (N00014-99-1-0851). Also, the simulation capability is being utilized and augmented under the ONR SBIR (code 321OE) "USBL Positioning of Littoral Swarm Systems" (N00014-97-C-0288) in collaboraion with IS Robotics.

RELATED PROJECTS

This effort is part of the US component of the GOATS`2000 Joint Research Project (JRP) with the SACLANT Undersea Research Centre. The MIT GOATS effort is funded by ONR codes 321OA (Simmen), 321OE (Swean), 321TS (Jacobson), and 322OM (Curtin).

The GOATS effort is strongly related to the ONR Autonomous Ocean Sampling Network (AOSN) initiative. Thus the GOATS'98 experimental effort was funded in part by the AOSN MURI, (PI: J. Bellingham). In terms of the fundamental seabed penetration physics there are strong relations to the High-Frequency Bottom Penetration DRI (PI: E. Thorsos). This effort also builds on acoustic modeling efforts initiated under the Sea-Ice Mechanics Initiative (SIMI), and continued under funding from ONR code 321OA (Simmen).

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PUBLICATIONS

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